

Recurrent chylothorax treated with thoracic duct–venous anastomosis: A retrospective review of medical records



Hexiao Tang, MD, PhD,^{a,b} Xuefeng Zhou, MD, PhD,^a Ming Xu, MD, PhD,^a and Jinping Zhao, MD, PhD^a

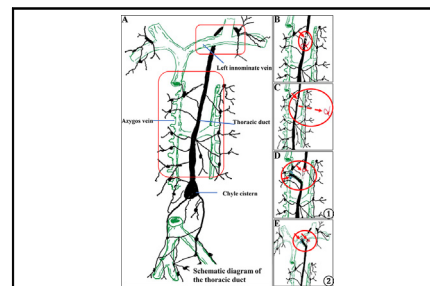
ABSTRACT

Objectives: Clinically, recurrent chylothorax is challenging to solve, especially when chylothorax is still present after the thoracic duct is ligated. In this study we explored alternative surgical options to treat complex cases of recurrent chylothorax.

Methods: Clinical records, laboratory results, and magnetic resonance imaging scans were retrospectively reviewed for 3 patients with recurrent chylothorax who were admitted to Zhongnan Hospital of Wuhan University, Wuhan, China, from August 8, 2016, to October 30, 2019. Evidence from the surgical treatment of thoracic duct–venous anastomosis was assessed using pictures from the operation room, with follow-up until now.

Results: Thoracic duct ligation had failed twice in patient 1, and the other 2 patients each had thoracic duct ligation that failed once again. After undergoing thoracic duct ligation, all 3 patients showed a significant reduction in chest fluid, but their condition soon returned to the same as that before ligation. All 3 patients finally underwent thoracic duct–venous anastomosis. The changes in lymphocyte and granulocyte numbers in the blood system of the patients before and after the operation were not substantial, and the operations had little effect on liver and kidney function. The patients achieved satisfactory treatment results, with follow-up until the present (23–60 months).

Conclusions: This research shows that thoracic duct–venous anastomosis is a safe and effective alternative surgical approach for complex recurrent chylothorax. (JTCVS Techniques 2022;15:199–205)



Chylothorax treated with thoracic duct–venous anastomosis.

CENTRAL MESSAGE

When repeated ligation of the thoracic duct cannot cure patients with persistent complex recurrent chylothorax, it is recommended to anastomose the thoracic duct and vein.

PERSPECTIVE

Especially when repeated ligation of the thoracic duct cannot cure patients with persistent complex recurrent chylothorax, it is not recommended to continue ligation of the thoracic duct. It is recommended to anastomose the thoracic duct and vein to reduce the pressure of the thoracic duct, with lymph drainage into the vein, which is closer to normal physiological characteristics.

Rupture or damage to the thoracic duct will cause a large amount of chylous fluid to accumulate in the chest.¹ It is a rare cause of pleural effusion and has a wide range of differential diagnoses, classified as traumatic or nontraumatic. In contrast, injury to below the fifth thoracic vertebra can cause fluid to accumulate on the right.² Surgical treatment is also the primary treatment method for chylothorax, especially postoperative chylothorax, including after surgery for

esophageal cancer and lung cancer.³ High thoracic duct ligation can easily cause obstruction and increase the risk of repeated thoracic duct rupture and recurring chylothorax. Thoracic duct ligation for the treatment of chylothorax is currently recognized worldwide as a standard practice.⁴ However, it is still a challenging problem for patients in whom chylothorax is present after more than 1 ligation operation.

From the ^aDepartment of Thoracic Surgery, and ^bMediastinal Cancer Center, Zhongnan Hospital of Wuhan University, Wuhan, China.

This project was supported by the Natural Science Foundation of Hubei Province (2020CFB703).

Hexiao Tang and Xuefeng Zhou are co-first authors.

Received for publication April 27, 2022; revisions received July 6, 2022; accepted for publication July 11, 2022; available ahead of print Aug 2, 2022.

Address for reprints: Ming Xu, MD, PhD, and Jinping Zhao, MD, PhD, Department of Thoracic Surgery, Zhongnan Hospital of Wuhan University, Wuhan 430071,

China (E-mail: xuking0322@sina.com and Zhaojphtx@126.com); or Hexiao Tang, MD, PhD, Zhongnan Hospital of Wuhan University, Wuhan 430071, China (E-mail: thx1245@sina.com).

2666-2507

Copyright © 2022 The Authors. Published by Elsevier Inc. on behalf of The American Association for Thoracic Surgery. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

<https://doi.org/10.1016/j.jtc.2022.07.015>

Abbreviation and Acronym

MRI = magnetic resonance imaging

METHODS

Study Design and Patients

We performed a retrospective review of medical records of 3 patients with complex recurrent chylothorax who were admitted to Zhongnan Hospital of Wuhan University from August 8, 2016, to October 30, 2019. This study was reviewed and approved by the Medical Ethical Committee of Zhongnan Hospital of Wuhan University (approval number 2021100K, May 9, 2021). Written informed consent was obtained from each enrolled patient.

Data Collection

We reviewed clinical records, laboratory findings, and magnetic resonance imaging (MRI) scans for all 3 patients. All information was obtained and curated with a customized data collection form. Two study investigators (THX and ZXF) independently reviewed the data collection forms to verify data accuracy. All data and materials in this article are available.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics 25.0. Continuous variables are expressed as ranges. Categorical variables are expressed as numbers (%).

RESULTS

Cases Summary

The 3 patients included 2 women and 1 man, all younger than 60 years old (Table E1 and Appendix E1). After thoracic duct ligation was performed once again, the treatment effects were not satisfactory. Finally, the thoracic duct was released and anastomosed with the vein. The laboratory examination results (Table E2) of the 3 patients showed no significant changes in lymphocytes and granulocytes, such as neutrophils, lymphocytes, monocytes, and eosinophils, before and after the operation (thoracic duct–venous anastomosis).

Preoperative and postoperative examinations of the thoracic ducts were performed using MRI (Table E3). The appearance of the patients' thoracic ducts before, during,

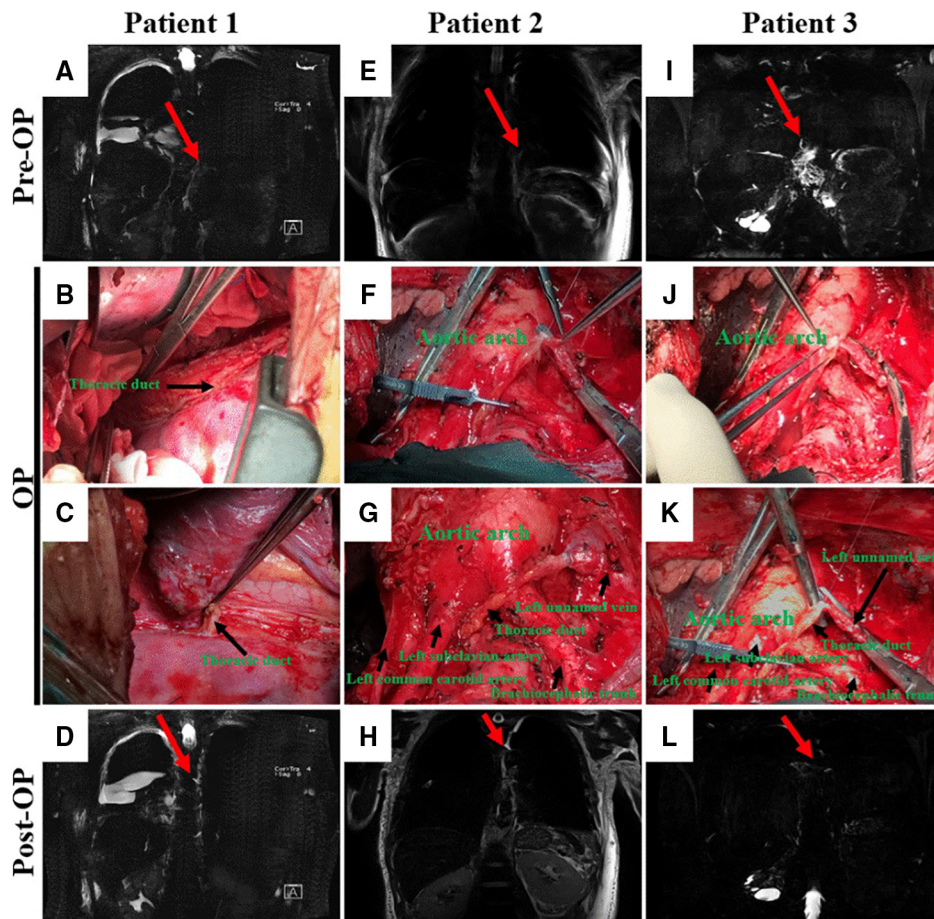


FIGURE 1. The operation of thoracic duct–vein anastomosis. The preoperative (*Pre-OP*) magnetic resonance images of the 3 patients showed that the thoracic duct was not continuous (A, E, and I). During the operation, patient 1 underwent thoracic duct–azygos venous anastomosis (B and C), and patients 2 and 3 underwent thoracic duct–left innominate vein anastomosis (F, G, J, and K). Postoperative (*Post-OP*) magnetic resonance images showed that the thoracic duct was unobstructed (D, H, and L). *OP*, The operation of thoracic duct and vein anastomosis.

and after surgery are shown in Figure 1. The surgical process of thoracic duct–venous anastomosis (Figure 2) was as follows: (1) the mediastinal pleura was cut to explore the thoracic duct and look for the ligation breach, (2) after finding the azygos or the left innominate vein closest to the vicinity, this vein was clipped, (3) the thoracic duct and respective vein were connected (using 7-0 Prolene to anastomose the chyle duct to the vein), the other end (distal end) of the thoracic duct was ligated and closed because of injury or tumor resection (Figure 2, D and E), (4) the thoracic duct and

the vein were checked to determine whether the duct was open and whether there was a clot. The 3 patients were followed-up for 23 to 60 months (Table E3).

DISCUSSION

Low thoracic duct ligation can theoretically treat chylothorax, but there is no fundamental solution to the problem of chyle leakage.⁵ Chylothorax can reappear because of thoracic duct variability, ligation sites not including fistulas, elevated thoracic duct pressure due to multiple ligations,

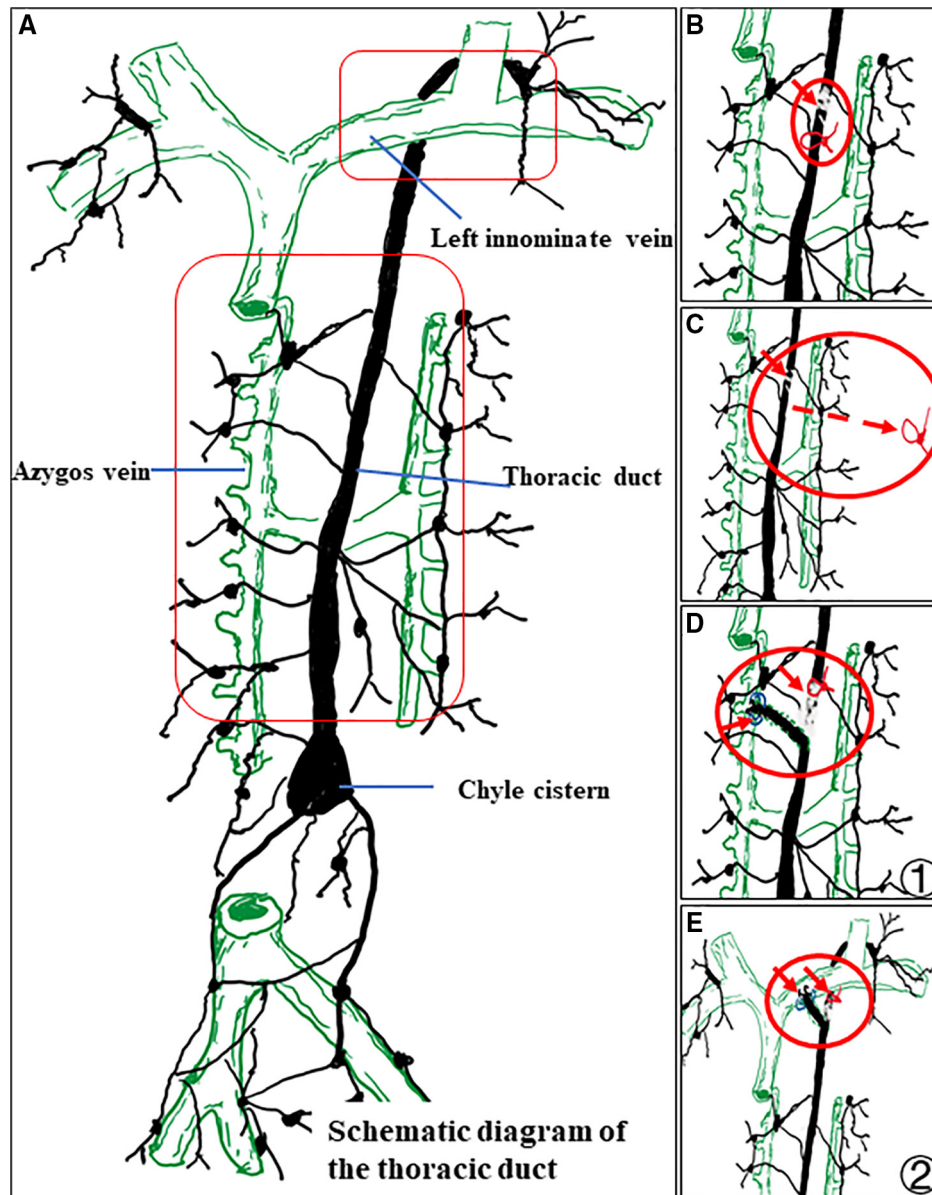


FIGURE 2. Flow chart of thoracic duct–vein anastomosis. Our team collected pictures of the main lymphatic system of the human body (A). To address recurrent chylothorax on the basis of the ligation of or leakage from the thoracic duct (B, red), including surgical or nonsurgical factors (yellow), we found the rupture site (C, red) or released the ligation site (C, red) if there was a history of ligation operation, and then anastomosed (with 7-0 Prolene) the thoracic duct with the azygos vein (D, purple) or the left innominate vein (E, purple).

thoracic duct ligation line cleavage, chest and abdomen wound fluid, and other reasons. In this situation, this simple ligation of the thoracic duct is not suitable for the treatment of chylothorax. In our patients, thoracic duct ligation was performed (some 2 times), and the patients continued to experience chylothorax, highly consistent with our previously mentioned theoretical analysis. Therefore, instead of ligating the thoracic duct, we chose to release the ligated thoracic duct and then anastomosed the thoracic duct and vein, and we achieved remarkable postoperative effects (Figures 1 and 2). The laboratory results (Table E2) of the 3 patients showed no significant changes in lymphocytes and granulocytes, such as neutrophils, lymphocytes, monocytes, eosinophils, and eosinophils, before and after the operation.

CONCLUSIONS

Our research shows that recurrent chylothorax treated using thoracic duct–venous anastomosis is a safe and effective alternative surgical approach. In particular, when repeated ligation of the thoracic duct does not cure patients with persistent complex recurrent chylothorax, continued ligation of the thoracic duct is not recommended. However, thoracic duct and vein anastomosis can reduce the pressure in the thoracic duct, with lymph drainage into the vein, at closer to normal physiological levels.

Conflict of Interest Statement

The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

We thank all of our colleagues who helped us during the current study. We greatly appreciate the kind assistance of doctors in the Department of Thoracic Surgery, Zhongnan Hospital of Wuhan University, for the assistance in discussing the key issues of this study.

References

1. McGrath EE, Blades Z, Anderson PB. Chylothorax: aetiology, diagnosis and therapeutic options. *Respir Med*. 2010;104:1-8.
2. Papoulidis P, Vidanapathirana P, Dunning J. Chylothorax, new insights in treatment. *J Thorac Dis*. 2018;10:S3976-7.
3. Jeon YJ, Cho JH, Hyun D, Shin S, Kim HK, Choi YS, et al. Management of chyle leakage after general thoracic surgery: impact of thoracic duct embolization. *Thorac Cancer*. 2021;12:1382-6.
4. Lampson RS. Traumatic chylothorax; a review of the literature and report of a case treated by mediastinal ligation of the thoracic duct. *J Thorac Surg*. 1948;17:778-91.
5. Polistena A, Vannucci J, Monacelli M, Lucchini R, Sanguinetti A, Avenia S, et al. Thoracic duct lesions in thyroid surgery: an update on diagnosis, treatment and prevention based on a cohort study. *Int J Surg*. 2016;28(Suppl 1):S33-7.

Key Words: recurrent chylothorax, thoracic duct, azygos venous, anastomosis

APPENDIX E1. THE OPERATION RECORDS**Patient 1 (ID 1042928)****Thoracic duct–zygostomy anastomosis.**

1. The patient was placed in the left lateral decubitus position using general anesthesia with double lumen intubation, routine disinfection, and drape. The original chest drainage tube was removed.
2. A small incision was made on the anterolateral side of the fifth intercostal space on the right, approximately 20 cm long, and the chest was explored. There was no obvious adhesion in the pleural cavity, no abnormal nodular lesions in the local pleura, and no pleural damage. Approximately 800 mL of milky white effusion was seen in the pleural cavity, and the azygos vein arch. Fluid extravasation was vaguely visible at the lower edge.
3. The azygos vein was freed along its medial border, and the diameter of the thoracic duct was approximately 2 mm, and several lymphatic branches were seen. The specific damage was not obvious. There appeared to be a decrease in exudate after clipping of the lymphatic branches. The branches of the intercostal vein proximal to the azygos vein were blocked with sutures, the upper and lower ends of the anastomotic area were blocked, and the distal end of the thoracic duct was blocked (side-to-side anastomosis). The operation field was observed with direct vision for approximately 30 minutes, and no obvious fluid extravasation was found.
4. The wound surface was tightly hemostasis, and the thoracic drainage tube was indwelled. The operation went smoothly and the patient returned to the ward. The patient received postoperative anti-infection, hemostasis, and fluid support therapy.

Patient 2 (ID 1094065)**Thoracic duct–innominate vein anastomosis.**

1. The patient was placed in the left lateral decubitus position using general anesthesia with double-lumen intubation, routine disinfection, and drape. The original chest drainage tube was removed.
2. A small incision was made on the anterolateral side of the fifth intercostal space on the right, approximately 20 cm long, and the chest was explored. There was no

obvious adhesion in the pleural cavity, no abnormal nodular lesions in the local pleura, no pleural damage, and approximately 200 mL of milky white effusion in the pleural cavity and azygos vein arch. Fluid extravasation was vaguely visible at the lower edge.

3. The azygos vein was freed along its medial border, and the diameter of the thoracic duct was approximately 2 mm, and several lymphatic branches were seen. The specific damage was not obvious. The branches of the intercostal vein proximal to the azygos vein were blocked with sutures, the upper and lower ends of the anastomotic area were blocked, and the distal end of the thoracic duct was blocked. Thoracic duct–innominate vein side-to-side anastomosis with 7-0 sliding suture was performed. The operation field was observed with direct vision for approximately 30 minutes, and no obvious fluid extravasation was found.
4. The wound surface was tightly hemostasis, and the thoracic drainage tube was indwelled. The operation went smoothly and the patient returned to the ward. The patient received postoperative anti-infection, hemostasis, and fluid support therapy.

Patient 3 (ID 1366474)

Thoracic duct–innominate vein anastomosis. The patient was placed in the left lateral decubitus position with a sterilized drape on the chest. A right posterolateral incision was made, through the fifth intercostal space into the chest. In intrathoracic exploration, there was no adhesion between the lung and the chest wall, and there was approximately 800 to 1000 mL of milky white liquid in the chest. At the lower border of the azygos arch, between the esophagus and the azygos vein, the mediastinal pleura was incised down to the level of the eighth thoracic vertebra. The thoracic duct was found to be small at the left edge of the thoracic vertebrae, but thickened at the level of the azygos arch, which was basically consistent with the MRI findings. On the right edge of the spine, it was found that the 2 thoracic ducts were interrupted after ascending to the T7 level. The thoracic duct and the innominate vein at the confluence were slightly dissociated, and the 2 were anastomosed with 7-0 Prolene. After anastomosis, white fluid flowed into the innominate vein. Bleeding was stopped, a chest drain was placed, and the chest was closed.

TABLE E1. Clinical characteristics

Sex	Patient 1 Female	Patient 2 Male	Patient 3 Female	n (%)
Age, y	40	56	47	–
History of disease	BA, RLM, ST	MT, HY, MN, RI, HE	UR, HY	–
Primary disease	TH (B2), MG	SC	SC	–
TDI, yes or no (after treatment for primary disease)	Yes	No	No	1 (33)
TDI by a senior thoracic surgeon (first)	Yes	No	No	3 (100)
Pleural effusion before first TDI, volume (mL), color, and CQT (–/+)				
Day 1	300, LY, +	400, MI, +	550, MI, +	–
Day 2	800, MI, +	500, MI, +	700, MI, +	–
Day 3	1500, MI, +	650, MI, +	900, MI, +	–
Pleural effusion after first TDI, volume (mL), color, and CQT (–/+)				
Day 1	100, LY, –	–	–	–
Day 2	200, MI, +	–	–	–
Day 3	1400, MI, +	–	–	–
TDI (second), yes or no	Yes	No	No	3 (100)
TDI by a senior thoracic surgeon (first or second)	Yes	Yes	Yes	3 (100)
Pleural effusion after second (or first) TDI, volume (mL), color, and CQT (–/+)				
Day 1	50, LY, –	100, LY, +	120, LY, +	–
Day 2	350, MI, +	400, MI, +	380, MI, +	–
Day 3	1800, MI, +	1600, MI, +	1500, MI, +	–
TDAVA with	Azygos vein	Left innominate vein	Left innominate vein	–
Pleural effusion after TDAVA, volume (mL), color, and CQT (–/+)				
Day 1	80, LY, –	50, LY, –	65, LY, –	–
Day 2	100, LY, –	120, LY, –	80, LY, –	–
Day 3	150, LY, –	140, LY, –	160, LY, –	–

CQT results shown as “–” indicates normal and results shown as “+” indicates presence of chyle. BA, Barrett esophagus; RLM, resection of left mandibular mass; ST, supra-ventricular tachycardia; MT, mediastinal tumors; HY, hypertension; MN, membranous nephropathy; RI, renal insufficiency; HE, hypothyroidism erysipelas; UR, uremia; TH, thymoma; MG, myasthenia gravis; SC, spontaneous chylothorax; TDI, thoracic duct ligation; CQT, chyle qualitative test; LY, light yellow; MI, milky; TDAVA, thoracic duct–azygos venous anastomosed.

TABLE E2. Laboratory characteristics

	Patient 1		Patient 2		Patient 3		Normal range
	Pre-OP	Post-OP	Pre-OP	Post-OP	Pre-OP	Post-OP	
Neutrophils, %	92.60	89.90	83.70	88.40	73.80	87.30	40-75
Neutrophils, $\times 10^9/L$	30.60	15.30	9.13	11.21	5.46	10.28	1.8-6.3
Lymphocytes, %	1.00	1.80	8.30	4.40	13.00	6.20	20-50
Lymphocytes, $\times 10^9/L$	0.30	0.30	0.91	0.56	0.96	0.73	1.1-3.2
Monocytes, %	6.20	7.60	7.80	6.90	6.80	5.90	3-10
Monocytes, $\times 10^9/L$	2.00	1.30	0.85	0.87	0.50	0.69	0.1-0.6
Eosinophils, %	0.10	0.50	0.10	0.00	5.50	0.30	0.4-8
Eosinophils, $\times 10^9/L$	0.01	0.10	0.01	0.01	0.41	0.04	0.02-0.52
Basophils, %	0.10	0.20	0.10	0.30	0.80	0.30	0-1
Basophils, $\times 10^9/L$	0.01	0.00	0.01	0.04	0.06	0.03	0-0.06
ALT, U/L	12.00	25.00	39.00	26.00	14.00	15.00	9-50
AST, U/L	10.00	25.00	31.00	22.00	16.00	20.00	15-40
TBIL, $\mu\text{mol/L}$	10.30	4.50	3.30	7.70	4.00	8.60	5-21
DBIL, $\mu\text{mol/L}$	3.70	2.40	1.40	1.60	0.50	1.30	0-7
IDBIL, $\mu\text{mol/L}$	1.80	2.10	1.90	6.10	3.50	7.30	1.5-18
TP, g/L	56.10	58.10	36.20	37.60	65.20	51.40	65-85
ALB, g/L	38.10	33.90	14.40	18.90	32.00	24.10	40-55
GLB, g/L	18.00	24.20	21.80	18.70	33.20	27.30	20-40
GLU, mmol/L	6.07	6.91	3.98	4.32	4.63	6.80	3.9-6.1
BUN, mmol/L	4.20	3.90	22.20	18.00	25.04	21.71	2.8-7.6
CREA, $\mu\text{mol/L}$	35.60	30.90	100.00	125.00	885.40	674.20	64-104
UA, $\mu\text{mol/L}$	88.80	54.80	527.00	567.80	419.40	369.60	208-428

OP, The operation of thoracic duct and vein anastomosis; ALT, alanine aminotransferase; AST, aspartate aminotransferase; TBIL, total bilirubin; DBIL, direct bilirubin; IDBIL, indirect bilirubin; TP, total protein; ALB, albumin; GLB, globulin; GLU, glucose; BUN, urea nitrogen; CREA, creatinine; UA, uric acid.

TABLE E3. Characteristics after thoracic duct and vein anastomosis

	Patient 1		Patient 2		Patient 3		n (%)
	Pre-OP	Post-OP	Pre-OP	Post-OP	Pre-OP	Post-OP	
MRI evidence pre- and post-OP							
Thoracic catheter continuation	No	Yes	No	Yes	No	Yes	3 (100)
Follow-up, mo		60		49		23	–
Outcomes							
Pleural effusion		No		No		No	0
Chest pain		No		No		No	0
Other related complications		No		No		No	0

OP, The operation of thoracic duct and vein anastomosis; MRI, magnetic resonance imaging.